An Instrument for Measuring the Distance between the Centres of Rotation of the Two Eyes.

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A knowledge of the distance between the two eyes being required in dealing with the problems of binocular vision, the instruments described in this paper may be of interest to physiologists. All those methods which involve measurement of the distance between the pupils (or other external parts of the eyes) are liable to errors, for the following reasons:—

1. It is difficult to eliminate parallax between the scale or index of the measuring instrument and the eyes.
2. The distance between the pupils is affected by the convergence of the optical axes, and still more by the abnormal direction of either.
3. It is difficult to ensure the eyes being kept still during the process of measuring.

By the method herein described, advantage is taken of the mobility of the eyes, which is the cause of this very difficulty, to measure the one distance that cannot vary, namely, that between the optical centres of rotation. So far as we have been able to find, this has not been done before. We have made two instruments, each involving the same general principles in a different form.

The first form (fig. 1) consists of a suitable base A, shaped at one end to fit the forehead, and carrying at the other end a vulcanite plate B, upon which slides a vertical index C, against a scale SS. In the base itself there is a vertical index which may be placed at either D or E. When in use

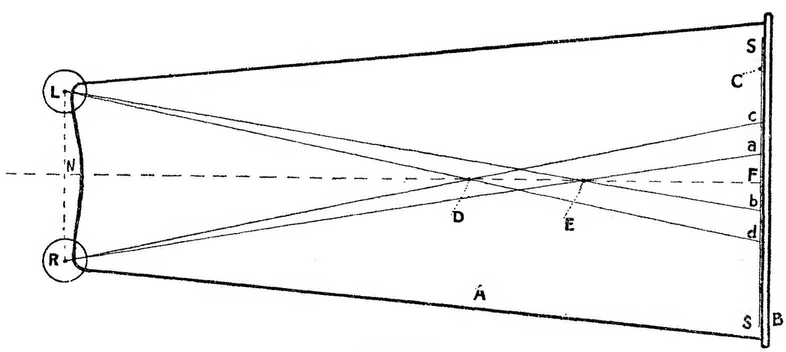

Fig. 1.

the instrument is held in front of the face with the shaped end against the forehead. One eye, say the left, is covered, and the patient is instructed, the first index being at D, to move the scale index along the plate B until it apparently lies just behind the first index at *a*. Without altering the position of the instrument, a similar observation is made with the other eye, the scale index being moved to *b*. The first index is now moved to E, and similar observations taken for each eye, giving the readings *c* and *d* respectively for the scale index.

Then (in fig. 1) join LR, and produce DE to F and to N. Let the distance $ab = y$, $cd = y'$, $\mathrm{EF} = x$, $\mathrm{ED} = d$, $\mathrm{ND} = z$.

Let R be the position of the right eye and L that of the left, and let $\mathrm{RL} = \mathrm{V}$ be the distance between the centres of rotation. Then V may be determined graphically by a simple construction, or, assuming the base line RL to be parallel to SS, may be calculated as follows :—

From fig. 1 we have

$$\frac{\mathrm{V}(d+x)}{y'} = z \quad \text{and} \quad \frac{\mathrm{V}x}{y} = z+d,$$

from which

$$\mathrm{V}\left(\frac{x}{y} - \frac{d+x}{y'}\right) = d, \quad \text{or} \quad \mathrm{V} = \frac{d\,(yy')}{xy' - y\,(d+x)}.$$

In practice, as only two variables occur in this equation, namely y and y', a table may be computed and used with the instrument.

In the second form (fig. 2) the instrument has three fixed vertical indices, K, L′, and M. The vulcanite plate and sliding index are similar to those

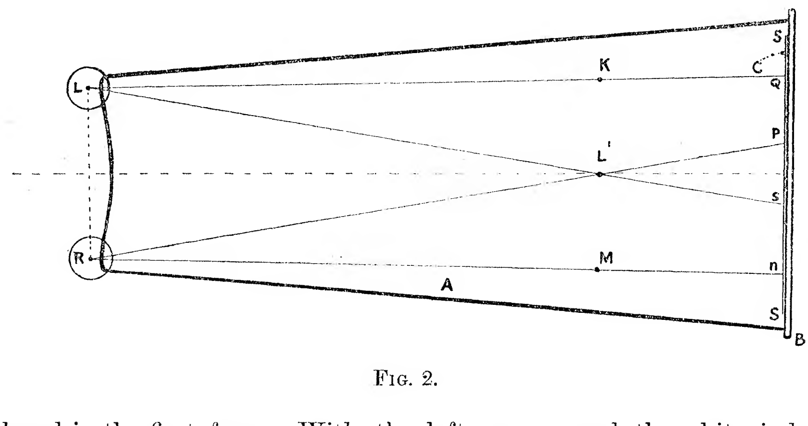

FIG. 2.

employed in the first form. With the left eye covered, the white index is moved till it is apparently behind L′ at *p*, and M at *n*. Similar observations are taken with the left eye, the scale index being moved till it is apparently behind the indices K and L′ at *q* and *s* respectively. As with the first instrument described, the distance $\mathrm{RL} = \mathrm{V}$ may be obtained from a simple

geometrical construction, or, assuming parallelism between the base line RL and the scale SS, V may be calculated from the following data :—

Let the distance KM $= a$, $ps = b$, $qn = c$, RL $=$ V.

Then from fig. 2 we have

$$b : \mathrm{V} = c - a : a - \mathrm{V}, \quad \text{or} \quad ab - b\mathrm{V} = (c-a)\,\mathrm{V};$$

that is

$$\mathrm{V} = ab/(b+c-a).$$

Since a is constant for a given instrument, the values of V may in practice be obtained from a table computed in terms of b and c.

Further, it may be pointed out that in all the methods hitherto employed for measuring the distance between the centres, it is essential that the subject should have binocular vision, in order to enable him to fix an object with both eyes simultaneously. By either of the methods just described it is possible to measure the distance between the centres of persons who cannot fuse the images of the two eyes, or even, provided the vision of each eye be sufficient, to measure this distance in the case of persons who squint. Moreover, it is not necessary that the vision should be distinct so long as the eye can distinguish the index. Good measurements can be made even though the definition is not sufficient to enable large print to be read. Various methods may be used to increase accuracy of scale reading, such as verniers and multiplying levers.